Revised Draft

Phase 2 Focused Feasibility Study
Technical Memorandum LNAPL Interim Remedial Measure Technology Screening and Evaluation

for the
Diamond Head Oil Superfund Site
Kearny, New Jersey

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Table of Contents

List of Tables

1.0 Introduction

This revised Technical Memorandum (TM) is submitted to the U.S. Environmental Protection Agency (USEPA), Region 2, as part of Task Order DH02 under Contract Number DACA87-02-D-0006 with the Army Corps of Engineers, Huntsville District.

The purpose of this TM is to present the results of the screening and evaluation for likely remedial technologies that can be used as part of an interim remedial measure (IRM) for the light non-aqueous phase liquid (LNAPL) currently found at the Diamond Head Oil Superfund Site ("site") located in Kearny, Hudson County, New Jersey. This TM includes identification of applicable or relevant and appropriate requirements, response action objectives, and preliminary remedial goals as well as initial screening of technologies based on *implementability, cost, and effectiveness criteria.*

This technical memorandum is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Background and History
- Section 3 – Nature and Extent of LNAPL within the Source Area
- Section 4 – Summary of Applicable or Relevant and Appropriate Requirements
- Section 5 – Response Action Objectives
- Section 6 – Preliminary Remedial Goals (PRGs)
- Section 7 – Identification, Screening, and Evaluation of Technologies
- Section 8 – Conclusions
- Section 9 – References

2.0 Site Background and History

The Site is currently inactive and consists of approximately 15 acres of undeveloped land located near the Hackensack Meadowlands. The property is currently owned by the Hudson Meadows Urban Development Corporation. The area surrounding the Site is industrial; there are no residential areas in the vicinity of the Site. Land use within 1000 feet of the Site consists of light industrial to the north, northwest and west and wetlands (meadowlands) to the east, northeast, and south.

The Site is a former oil-reprocessing facility that operated from February 1, 1946, to early 1979. During facility operations, multiple aboveground storage tanks (ASTs) and possibly below grade pits were used to store oily wastes. These wastes were intermittently discharged directly to adjacent properties to the east and the wetland area on the south side of the Site, creating an oil lake. From the close of operations in 1979 until 1982, the abandoned site was not completely fenced. It was reported that during this time, oily wastes and other debris were dumped at the Site (CH2M HILL 2005).

In 1968, the New Jersey Department of Transportation (NJDOT) acquired the property to the south of the Site, and in 1977, when beginning construction of I-280, reportedly removed 9 million gallons of oil-contaminated water and 5–6 million cubic yards of oily sludge from

the oil lagoon. The NJDOT also reported that during the I-280 construction, an underground "lake" of oil-contaminated groundwater was found extending from the eastern limits of the I-280 right-of-way to Frank's Creek to the west of the Site. During the process of constructing I-280, the entire oil lagoon was apparently filled, as it no longer appears on post–I-280 construction aerial photographs. There is no further information on the oil and sludge removal from the lagoon and whether the excavation was completed to the native soils prior to filling or a sludge layer was left at the bottom of the lagoon.

In 1982, approximately 7,500 gallons of materials were apparently pumped out of the tanks and disposed off site. During the same time, 27 tons of contaminated soil were reportedly removed from the Site (location at the Site from where they came is unknown). Aerial photographs from 1982 show that the reprocessing infrastructure of the Site had been dismantled.

3.0 Nature and Extent of LNAPL within the Source Area

A Phase 1 Remedial Investigation (RI) (CH2M HILL 2005) was conducted and outlined three areas as potential sources that may be continuing to release contamination to the environment:

- Landfill—with an approximate area of 7 acres
- Oil-reprocessing section of the Site—with two buildings, multiple ASTs, drum storage areas, and possibly underground pits
- Oil lagoon—with an approximate area of 5 acres located over the south section of the Site and extending outside the Site's boundaries to the east and south

Currently, in the oil-processing section of the Site, only the foundations of one of the buildings and two of the ASTs are visible. While the general location of the landfill can be identified, its exact limits are often unclear because the elevation changes gradually and debris is present over the entire Site and cannot serve as a demarcating factor. There are no physical demarcations at the Site that can be used to establish the boundary of the former lagoon. Historic information suggests that the lagoon occupied the southeast section of the Site and extended eastward beyond the current boundary of the Site.

During the Phase 1 RI, evidence of the presence of LNAPL was found throughout the site east of the landfill. The LNAPL was estimated to cover approximately 80,000 ft^2 in area, affecting between 2,800 and 5,000 cubic yards of the vadose zone. In the southeast section of the site – within the footprint of the former oil lagoon – the thickness of LNAPL in some monitoring wells was measured up to approximately 5 ft (CH2M HILL 2005). Based on these results, the USEPA determined that there was a need to perform an Interim Remedial Measure (IRM) to address this source of contamination. A Phase 2 Focused Remedial Investigation was thus initiated in 2007 to further delineate the source area of LNAPL. The investigation concluded the following:

- LNAPL was measured in wells in three separate areas of the site: the main plume around piezometers PZ-7 and PZ-10, a second area between MW-13S and PZ-14, and a newly observed occurrence at PZ-16. While it was not measured in wells in other areas of the site, the Laser Induced Fluorescence (LIF) study conducted at the site concluded that the LNAPL is present in the subsurface throughout almost the entire investigated area.

- The LNAPL is distributed from the water table (approximately 2 feet bgs) through the saturated zone to depths of 16 feet bgs in some locations.
- The vertical occurrence of LNAPL can be further separated into two depth intervals: 1) at the water table and sometimes with an extended smear zone into the saturated fill-containing material/soil up to 9.5-feet bgs, and 2) occurring as a distinct deeper interval at depths of 10- to 16-feet bgs within silty/clayey soils. The bulk of LNAPL-containing soil is predominantly located near the water table within the fill layer, but a large volume is also present within the silty/clay soils in the deeper stratigraphic zones.
- Despite the large thickness of LNAPL found in some monitoring wells and its relatively high saturation, the LNAPL is extremely viscous and is relatively immobile under ambient gradients. The soil conductivity to LNAPL is very low (equivalent to less than 10^{-5} cm/s for water in soil) and the estimated seepage velocity of the LNAPL was calculated to range from about 0.004 foot/year up to a maximum of only about 0.1 foot per year, suggesting very limited LNAPL mobility. The relatively immobile LNAPL is self-contained and therefore poses relatively low risk of future lateral migration.
- Based on potential remediation-induced LNAPL gradient analysis, the LNAPL is deemed poorly recoverable with any fluid recovery-based remediation system. Simplified LNAPL recovery modeling indicated that over a time period of 30 years, at most approximately 6 % of the LNAPL volume could be recovered.
- Within the area where LNAPL is found, there are pockets of less weathered LNAPL of high saturation where it presents a leaching concern to groundwater. These are the LNAPL areas that may be considered to present a risk for leaching contaminants to groundwater. Some leaching potential exists for benzene and PCB isomers in the areas where the heterogeneous LNAPL exhibited the presence of these compounds.
- The LNAPL appears to contain more diesel range organics (DROs) than gasoline range organics (GROs).The following compounds or classes of compounds were detected in the LNAPL: benzene, toluene, ethylbenzene, xylenes as well as a number of other volatile and semi-volatile organic compounds consistent with a petroleum matrix; two PCBs (Arochlor 1232 and Arochlor 1260); and a variety of metals, including lead and cyanide.

4.0 Summary of Applicable or Relevant and Appropriate Requirements (ARARs) for the IRM

Remedial actions must be protective of public health and the environment. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed Applicable or Relevant and Appropriate Requirements (ARARs). The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements, as well as to adequately protect public health and the environment.

Definitions of the ARARs and the "to be considered" (TBC) criteria are given below:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance,

pollutant, contaminant, environmental action, location, or other circumstance at a CERCLA site.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, which while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a CERCLA site, that their use is well suited (appropriate) to the particular site.
- TBC criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing an interim remedial action, or are necessary for evaluating what is protective to human health and/or the environment. Examples of TBC criteria include the NJDEP Soil Cleanup Criteria for Impact to Groundwater (IGWSCC), as well as the USEPA Drinking Water Health Advisories, Reference Doses, and Cancer Slope Factors.

Another factor in determining which requirements must be addressed is whether the requirement is substantive or administrative. "Onsite" CERCLA response actions must comply with the substantive requirements but not with the administrative requirements of environmental laws and regulations as specified in the National Contingency Plan (NCP), 40 CFR 300.5, definitions of ARARs and as discussed in 55 FR 8756. Substantive requirements are those pertaining directly to actions or conditions in the environment. Administrative requirements are mechanisms that facilitate the implementation of the substantive requirements of an environmental law or regulation. In general, administrative requirements prescribe methods and procedures (e.g., fees, permitting, inspection, reporting requirements) by which substantive requirements are made effective for the purposes of a particular environmental or public health program.

ARARs are grouped into three types: chemical-specific, location-specific, and action-specific. Included in Tables 1A through 1C are the chemical-specific, action-specific, and location-specific ARARs for the site.

4.1 Chemical Specific ARARs

Chemical-specific ARARs include laws and requirements that establish health- or risk-based numerical values or methodologies for environmental contaminant concentrations or discharge. The chemical-specific ARARs for the LNAPL source area can be classified into two categories: (1) residual presence of LNAPL; and (2) land disposal restriction (LDR) concentrations that must be achieved if contaminated media that is either a characteristic hazardous waste or contains a listed hazardous waste, is excavated or extracted and later land disposed. Also, effluent concentrations for treated groundwater and air emissions during treatment are considered chemical-specific ARARs.

The ARARs for the LNAPL at the site are the following New Jersey requirements for free-phase and residual LNAPL in NJAC 7:26E-1.13(b)2(v) and NJAC 7:26E-6.1(d):

- Removal or treatment of recoverable LNAPL where practicable
- Treatment of residual LNAPL where practicable
- Containment of LNAPL where removal or treatment are not practicable

It should be noted that the objective of the Phase 2 RI was the source LNAPL (mobile and residual) rather than the sorbed chemical contamination in the soils at the site. Additional investigations and feasibility evaluations are planned in the future to address the sorbed

chemical contamination at the site. For this sorbed contamination, the New Jersey Soil Cleanup Criteria would constitute ARARs.

The Resource Conservation and Recovery Act (RCRA) land disposal restrictions (LDRs) would apply to remedial actions performed at the site if waste generated by the remedial action (e.g., contaminated soil) contains a RCRA hazardous waste. Listed hazardous wastes as defined by RCRA regulation are not known to have been released at the site. As a result, excavated soils would not be required to be managed as listed hazardous wastes.

If excavated and removed from the area of contamination (i.e., the soil is "generated"), the soil may be a characteristic hazardous waste. Generated soils that exceed the Toxicity Characteristic Leaching Procedure (TCLP) limit must be managed as a hazardous waste and must meet the LDR Treatment Standards for contaminated soil (40CFR 268.49). The treatment standard for contaminated soil is the higher value of a 90 percent reduction in constituent concentrations or 10 times the Universal Treatment Standards (UTS). Treatment is required for the constituent for which the soil is a characteristic hazardous waste as well as other "underlying hazardous constituents". Generators of contaminated soil can apply reasonable knowledge of the likely contaminants present to select constituents for monitoring (USEPA, October 1998. *Management of Remediation Waste Under RCRA*, EPA530-F-98-026).

Depending on the selected remedial technology, wastes that may be generated include recovered LNAPL, excavated soil containing LNAPL and other constituents, vapor emissions, and recovered groundwater. Free-phase LNAPL and soil containing LNAPL have been sampled during both the Phase 1 and 2 RIs using the Toxicity Characteristic Leaching Procedure (TCLP), in order to determine requirements for disposal. The results have been below the regulatory limits for characteristic hazardous waste. The results from groundwater samples also suggest that the groundwater is not a characteristic hazardous waste. Therefore, for the purpose of the FFS, it is assumed that similar wastes generated during the IRM will continue to be classified as non-hazardous for disposal purposes. Because the quantity of soil that would be generated from a remedial action would be significant, it is expected however, that additional waste characterization (either in-situ or ex-situ) would be required by the disposal facility accepting the wastes.

For water generated during remedial actions, specific groundwater discharge requirements would need to be met. The two main effluent standards that would be applicable are:

Discharge to Public Treatment Works (POTW): Discharging treated groundwater to a POTW will require the construction of a discharge line and meeting the effluent chemical and volume requirements of the POTW. The discharge will likely need pretreatment before discharge, obtaining a permit for the discharge, and monitoring that the discharge meets the effluent limits established in the permit.

Discharge to surface water: Discharging treated groundwater to a surface water body would require that the discharge meet the surface water quality standards for the receiving water body. The discharge will likely need pretreatment before discharge, obtaining a permit for the discharge, and monitoring that the discharge meets the effluent limits established in the permit.

Discharge of treated groundwater through re-injection above the peat is considered impractical because of the shallow groundwater table.

Other chemical-specific requirements which apply are those related to air emissions during implementation of an IRM.

4.2 Action Specific ARARs

Action-specific ARARs regulate the specific type of action or technology under consideration, or the management of regulated materials. The most important action-specific ARARs that may affect the development of remedial action alternatives is RCRA. RCRA regulations governing the identification, management, treatment, storage, and disposal of solid and hazardous waste would be ARARs for alternatives that generate waste that would be moved to a location outside of the area of contamination. Such alternatives could include excavation of impacted soils. Requirements include waste accumulation, record keeping, container storage, disposal, manifesting, transportation and disposal. If generated soil is a characteristic hazardous waste, RCRA LDRs would apply and treatment would be required in accordance with RCRA prior to disposal. This includes treatment of other underlying hazardous constituents as required by 40 CFR 268.9(a).

4.3 Location Specific ARARs

Location-specific ARARs are requirements that relate to the geographical position of the site. State and federal laws and regulations that apply to the protection of wetlands, construction in floodplains, and protection of endangered species in streams or rivers are examples of location-specific ARARs. Early plans for the redevelopment of the site include converting the wetland area into the redevelopment footprint for the site and replacing it at another location to meet regulatory requirements. Based on this, the location-specific ARARs for the IRM do not include considerations for wetlands restoration following IRM implementation.

Table 1 Potential Chemical-Specific Applicable or Relevant and Appropriate Requirements
Diamond Head Oil Superfund Site, Kearny, New Jersey

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Federal				
Resource Conservation and Recovery Act	Identification and Listing of Hazardous Waste	40 CFR 261	Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and 270.	ARAR for wastes or treatment residues which are hazardous as defined by RCRA and are to be disposed of off-site.
Federal Safe Drinking Water Act	National Primary Drinking Water Standards - Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs)	40 CFR 141	Establishes health-based standards for public drinking water systems. Also establishes drinking water quality goals set at levels at which no adverse health effects are anticipated, with an adequate margin of safety. The NCP specifically states that MCLs will be used as ARARs for useable aquifers rather than the more stringent MCLGs.	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.
Federal Safe Drinking Water Act	National Secondary Drinking Water Standards-Secondary MCLs	40 CFR 143	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water (secondary MCL).	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.
Quality Criteria for Water	Water Quality Criteria	40 CFR 131 Quality Criteria for Water, 1976, 1980, and 1986	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	ARARs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits.
Federal Clean Water Act; National Pollution Discharge Elimination System (NPDES)	Toxic Pollutant Effluent Standards	40 CFR 129	Establishes effluent standards or prohibitions for certain toxic pollutants; I.e., aldrin/dieldrin, DDT, DDD, DDE, endrin, toxaphene, benzideine, and PCBs.	ARARs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits.
National Ambient Air Quality Standards (NAAQS)	Ambient Air Quality Standards	40 CFR 50	Defines air quality levels adequate to protect public health/welfare. Defines emissions limitations for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen oxide, and lead.	ARARs for remedial alternatives resulting in air emissions if toxic pollutants are present.
Federal Resource Conservation and Recovery Act	Groundwater Protection Standards and Maximum Concentration Limits	40 CFR 264, Subpart F	Establishes standards for groundwater protection for several metals and pesticides.	ARARs for groundwater concentrations following remediation but there are no standards for LNAPL.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Federal				
New Jersey				
Sludge Quality Criteria	Criteria for Sludge	NJAC 7:14-4 Appendix B-1	New Jersey Water Pollution Control Act Contaminant Indicators.	Potential ARAR for remedial alternatives resulting in the generation of sludges during groundwater or soil treatment.
State of New Jersey Statutes and Rules	Technical requirements for remediation of free product.	7:26E-1	Require removal or treatment of recoverable LNAPL where practicable; treatment of residual LNAPL where practicable; containment of potentially mobile LNAPL where removal or treatment are not practicable.	ARAR for the remediation of the LNAPL.
New Jersey Department of Environmental Protection Residential Direct Contact Soil Cleanup Criteria	Residential Soil Cleanup Standards in New Jersey	N.J.A.C. 7-26D	Direct contact cleanup criteria for soils at residential sites.	TBC. Not promulgated. NJDEP requires delineation of contamination to residential levels.
NJDEP Non-Residential Direct Contact Soil Cleanup Criteria	Non-Residential Soil Cleanup Standards in New Jersey	N.J.A.C. 7-26D	Direct contact cleanup criteria for soils at industrial or commercial sites.	TBC. Not promulgated. Criteria may be considered in setting cleanup goals for contaminated soils at source areas or areas where industrial activities are planned.
NJDEP Impact to Groundwater Soil Cleanup Criteria	Soil Cleanup Standards that are Protective of Groundwater in New Jersey	N.J.A.C. 7-26D	Soil cleanup criteria for protection of groundwater.	TBC. Not Promulgated. Criteria may be considered in setting cleanup goals for contaminated soils at source areas.
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9-6 Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups.	ARAR for Class IIA aquifers.
State of New Jersey Statutes and Rules	Drinking Water Standards-Maximum Contaminant Levels (MCLs)	N.J.A.C. 7:10 Safe Drinking Water Act	Establishes MCLs that are generally equal to or more stringent the SDWA MCLs.	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.
State of New Jersey Statutes and Rules	National Secondary Drinking Water Standards-Secondary MCLs	N.J.A.C. 7:10-7 Safe Drinking Water Act	Establishes standards for public drinking water systems for those contaminants which impact the aesthetic qualities of drinking water.	ARARs for groundwater concentrations following remediation but there are no MCLs for LNAPL.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Federal				
New Jersey Pollutant Discharge Elimination System (NJPDES)	Surface Water Discharge Criteria	N.J.A.C. 7:14a	Establishes discharge standards when written into permits.	ARARs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits.
Surface Water Criteria	New Jersey Criteria for Surface Water Quality	N.J.A.C. 7:9-4	Criteria for surface water classes	TBCs. If treated water needs to be discharged to surface water, these will be used in setting effluent discharge limits.
Prohibition of Air Pollution and Ambient Air Quality Standards	Air Quality Standards	N.J.A.C. 7:27-5 and N.J.A.C.7:27-13	Prohibits air pollution and establishes ambient air quality standards	Potential ARAR for remedial alternatives which include technologies that result in air emissions.

Table 2 Potential Action-Specific Applicable or Relevant and Appropriate Requirements
Diamond Head Oil Superfund Site, Kearny, New Jersey

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Discharge of Groundwater or Wastewater				
Federal Clean Water Act	National Pollution Discharge Elimination System (NPDES)	40 CFR 122 and 125	Issues permits for discharge into navigable waters. Establishes criteria and standards for imposing treatment requirements on permits.	ARAR for the disposal of groundwater to surface water, although state ARAR takes precedence for discharge permit.
Federal Clean Water Act	General Pretreatment Regulations for Existing and New Sources of Pollution	40 CFR 403	Prohibits discharge of pollutants to a POTW which cause or may cause pass-through or interference with operations of the POTW.	ARAR. Discharge of pollutants including those that could cause fire or explosion or result in toxic vapors or fumes to POTW. Discharge to POTW unlikely at this site.
Federal Clean Water Act	Effluent Guidelines and Standards for the Point Source Category	40 CFR 414	Requires specific effluent characteristics for discharge under NPDES permits.	ARAR for the disposal of groundwater to surface water, although state ARAR takes precedence for discharge permit.
Federal Clean Water Act	Ambient Water Quality Criteria	40 CFR 131.36	Establishes criteria for surface water quality based on toxicity to aquatic organisms and human health.	ARAR if remedial alternative includes groundwater discharge to surface water. Federally-approved New Jersey groundwater and surface water standards take precedence over the Federal criteria.
Federal Clean Water Act	Water Quality Criteria Summary		Includes non-promulgated guidance values for surface water based on toxicity to aquatic organisms and human health. Issued by the EPA office of Science and Technology, Health and Ecological Criteria Division.	ARAR if remedial alternative includes groundwater discharge to surface water. Supplements above-referenced Ambient Water Criteria.
Federal Safe Drinking Water Act	Underground Injection Control Program	40 CFR 144	Establishes performance standards, well requirements, and permitting requirements for groundwater re-injection wells.	ARAR if remedial alternative includes re-injection of treated water. May also apply to the injection of surfactants or oxidants into the aquifer.
Water Pollution Control Act	Protection of water	33 U.S.C. 1251	Protects and maintains the chemical, physical, and biological integrity of the nation's water.	ARAR for remedial actions which may affect water quality.
Water Treatment and Disposal				
Effluent Limitations	Discharge requirements	33 U.S.C. 1251 Section 301	Technology-based discharge limitations for point sources of conventional, nonconventional, and toxic pollutants.	ARAR for remedial actions which include discharge of wastewater.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Discharge of Groundwater or Wastewater				
Water Quality Related Effluent Limitations	Discharge requirements	33 U.S.C. 1251 Section 302	Protection of intended uses of receiving waters (e.g., public water supply, recreations uses).	ARAR for remedial actions which include discharge of wastewater.
Toxic and Pretreatment Effluent Standards	Pretreatment standards for discharge into POTWs.	33 U.S.C. 1251 Section 307	Establishes list of toxic pollutants and promulgates pretreatment standards for discharge into POTWs.	ARAR for remedial actions which include discharge of wastewater.
National Pollutant Discharge Elimination System (NPDES)	Permitting for discharge into navigable waters.	33 U.S.C. 1251	Issues permits for discharge into navigable waters.	ARAR for remedial actions involving discharge to surface water.
State of New Jersey Statutes and Rules	The New Jersey Pollutant Discharge Elimination System	N.J.A.C. 7:14A	Establishes standards for discharge of pollutants to surface and groundwaters.	ARAR for the disposal of groundwater to surface water.
State of New Jersey Statutes and Rules	Groundwater Quality Standards	N.J.A.C. 7:9-6 Groundwater Quality Standards	Establishes standards for the protection of ambient groundwater quality. Used as the primary basis for setting numerical criteria for groundwater cleanups and discharges to groundwater.	ARAR if disposal of treated groundwater by reinjection is needed.
State of New Jersey Statutes and Rules	Surface Water Quality Standards	N.J.A.C. 7:9B Surface Water Quality Standards	Establishes standards for the protection and enhancement of surface water resources.	ARAR for the disposal of groundwater to surface water.
State of New Jersey Statutes and Rules	Wastewater discharge requirements	N.J.A.C. 7:9-5.1	Minimum treatment requirements and effluent standards for discharge to surface water.	ARAR for the disposal of groundwater to surface water.
Worker and Community Right to Know Act	Protects workers and community	P.L. 1983c.315 P.L. 1985c.543 Executive Order #161	Notification of presence of hazardous substances to State Emergency Planning Commissions and to local Emergency Planning Committees.	ARAR. Applies to all on-site treatment alternatives.
Disposal of Hazardous Waste				
Federal Resource Conservation and Recovery Act	General Waste Management Practices	40 CFR 260	Establishes procedures and criteria for modification or revocation of any provision in 40 CFR Part 260-265.	ARAR. Establishes general requirements for hazardous waste management.
Federal Resource Conservation and Recovery Act	Identification and Listing of Hazardous Waste	40 CFR 261	Identifies solid wastes which are subject to regulation as hazardous wastes.	ARAR. Generation of a hazardous waste possibly including spent carbon or contaminated soil. Hazardous waste must be handled and disposed of in accordance with RCRA. Chemical testing and characterization of waste required.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Discharge of Groundwater or Wastewater				
Federal Resource Conservation and Recovery Act	Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Establishes requirements (e.g., EPA ID numbers and manifests) for generators of hazardous waste.	ARAR. Waste that is characterized as hazardous.
Federal Resource Conservation and Recovery Act	Standards Applicable to Transporters of Hazardous Waste	40 CFR 263	Establishes standards which apply to persons transporting manifested hazardous waste within the United States.	ARAR. Transport of waste that is characterized as hazardous.
Federal Resource Conservation and Recovery Act	Standards Applicable to Owners and Operators of Treatment, Storage and Disposal Facilities	40 CFR 264	Establishes the minimum national standards which define acceptable management of hazardous waste.	ARAR. Generation and storage of hazardous waste.
Federal Resource Conservation and Recovery Act	Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 265	Establishes minimum national standards that define the periods of interim status and until certification of final closure or if the facility is subject to post-closure requirements, until post-closure responsibilities are fulfilled.	Potential ARAR since remedies should be consistent with the more stringent 40 CFR 264 standards, as these represent the ultimate RCRA compliance standards and are consistent with CERCLA's goal of long-term protection of public health and welfare and the environment.
Federal Resource Conservation and Recovery Act	Land Disposal Restrictions	40 CFR 268	Identifies hazardous wastes which are restricted from land disposal. All listed and characteristic hazardous waste or soil or debris contaminated by a RCRA hazardous waste and removed from a CERCLA site may not be land disposed until treated as required by LDRs.	ARAR. Generated waste will need to meet LDRs for offsite disposal.
Federal Resource Conservation and Recovery Act	Hazardous Waste Permit Program	40 CFR 270	Establishes provisions covering basic EPA permitting requirements.	Potential ARAR. A permit is not required for on-site CERCLA response actions. Substantive requirements are added in 40 CFR 264.
Federal Resource Conservation and Recovery Act	RCRA	40 CFR 265	Establishes organic air emission standards for tanks, surface impoundments, and containers.	ARAR for hazardous waste treatment, storage, and disposal facilities (TSDFs) that receive new or re-issued permits or Class 3 modifications after 5 January 1995.
Federal Hazardous Material Transportation Act	Hazardous Materials Transportation Regulations	49 CFR 107, 171-177	Regulates transportation of hazardous materials.	ARAR since response action may involve transportation of hazardous materials.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Discharge of Groundwater or Wastewater				
State of New Jersey Statutes and Rules	Hazardous Waste	N.J.A.C. 7:26C Hazardous Waste	Establishes rules for the operation of hazardous waste facilities in the state of New Jersey.	Potential ARAR depending on hazardous waste disposal location.
General Remediation				
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and Superfund Amendments and Reauthorization Act of 1986 (SARA)	National Contingency Plan	40 CFR 300, Subpart E	Outlines procedures for remedial actions and for planning and implementing off-site removal actions.	ARAR.
Federal Occupational Safety and Health Act	Worker Protection	29 CFR 1904	Requirements for worker protection and for recording and reporting occupation injuries and illnesses.	ARAR. Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jurisdiction of the National Contingency Plan.
State of New Jersey Statutes and Rules	Technical Requirements for Site Remediation	N.J.A.C. 7:26E	Established minimum regulatory requirements for investigation and remediation of contaminated sites in New Jersey.	ARAR for all remedial action.
State of New Jersey Statutes and Rules	Emergency Response Notice of Release of Hazardous Substance to Atmosphere	NJSA 7:26, 26:2C-19	Control exposure to air pollution by immediate notification to the department hotline of any air release incident.	ARAR for any remedial alternative having the potential to result in an air release.
State of New Jersey Statutes and Rules	Notification of Spills	NJAC 7:21(E)	Immediate notification of any spill of hazardous substances.	ARAR for remedial alternatives having potential for a spill of a hazardous substance.
State of New Jersey Statutes and Rules	Restrictions of Noise	NJSA 13:1G-1 et.seq.	Prohibits and restricts noise which unnecessarily degrades the quality of life.	ARAR for all remedial action.
State of New Jersey Statutes and Rules	Investigation derived waste management	NJDEP's Guidance Document	Provides guidance on the disposition of IDW.	ARAR. To be considered during investigation.
State of New Jersey Statutes and Rules	Restrictions of Noise	NJAC 7:29-1	Sets maximum limits of sound from any industrial, commercial, public service or community service facility.	ARAR for all remedial actions.
State of New Jersey Statutes and Rules	General Requirements for Permitting Wells	NJAC 7:9-7	Regulates permit procedures, general requirements for drilling and installation of wells, licensing of well driller and pump installer, construction specification, and well casing.	ARAR when installing new wells or if existing wells should require modification.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Discharge of Groundwater or Wastewater				
State of New Jersey Statutes and Rules	Well Abandonment Procedures	NJAC 7:9-9	General requirements for sealing of all wells (e.g., single cased, multiple cased, hand dug, test wells, boreholes and monitoring wells, abandoned wells).	ARAR if any existing wells need to be abandoned and sealed.
State of New Jersey Statutes and Rules	Drilling Contractor Requirements	NJSA 58:4A-5 et.seq.	Well drillers licensing, supervision, inspection and sampling.	ARAR when additional wells are installed.
State of New Jersey Statutes and Rules	Groundwater Monitoring	N.J.A.C. 7:26-9	Groundwater monitoring system requirements.	ARAR for any remedial alternative requiring groundwater monitoring.
Off-Gas Management				
Federal Clean Air Act	National Primary and Secondary Ambient Air Quality Standards	40 CFR 50	Establishes emission limits for six pollutants (SO2, PM10, CO, O3, NO2, and Pb).	Emission of air polluntants may be of concern for some remedial technologies.
Federal Clean Air Act	Standards of Performance for New Stationary Sources	40 CFR 60	Provides emissions requirements for new stationary sources.	ARAR.
Federal Clean Air Act	National Emission Standards for Hazardous Air Pollutants	40 CFR 61	Provides emission standards for 8 contaminants including benzene and vinyl chloride. Identifies 25 additional contaminants, as having serious health effects but does not provide emission standards for these contaminants.	ARAR.
State of New Jersey Statutes and Rules	Standards for Hazardous Air Pollutants	N.J.A.C. 7:27 Air Pollution Control	Rule that governs the emitting of, and such activities that result in, the introduction of contaminants into the ambient atmosphere.	ARAR.
State of New Jersey Statutes and Rules	Permtting Conditions for air pollution control	N.J.A.C. 7:27-8	Establishes permit conditions for air pollution control apparatus.	ARAR if remedial action includes a technology that would result in air emissions.
State of New Jersey Statutes and Rules	Permtting Conditions for air pollution control	N.J.A.C. 7:27-11 and 17	Controls and prohibits air pollution, particle emissions, and toxic VOC emissions.	ARAR if remedial action includes a technology that would result in air emissions.
State of New Jersey Statutes and Rules	Incineration Requirements	N.J.A.C. 7:26-10	Specifies maximum air contaminant emissions rates, testing requirements, and minimum design standards.	ARAR if remedial alternative includes incineration.
State of New Jersey Statutes and Rules	Incineration Requirements	N.J.A.C. 7:26-11	Specifies maximum air containment emission rates, testing requirement, and minimum design standards during interim status.	ARAR if remedial alternative includes incineration.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Discharge of Groundwater or Wastewater				
State of New Jersey Statutes and Rules	Incinerator Permitting	N.J.A.C. 7:26-12	Delineates the information needs to be submitted in Part A and B of the permit application.	ARAR if remedial alternative includes incineration.

Table 3 Potential Location-Specific Applicable or Relevant and Appropriate Requirements
Diamond Head Oil Superfund Site, Kearny, New Jersey

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Executive Order Floodplain Management	Floodplain Management	Exec. Order No. 11988 40 CFR 2 6:302(b) and Appendix A	Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the maximum extent possible, the adverse impacts associated with direct and indirect development of a floodplain.	ARAR if remedial activities take place in or near a 100-year or 500-year floodplain.
Federal Flood Plains Regulatory Requirements	Regulatory Requirements	(RCRA Location Standards (40 CFR 264.18)	This regulation outlines the requirements for constructing a RCRA facility on a 100-year flood plain.	ARAR if remedial alternatives include construction in or near a 100-year floodplain.
National Wildlife System	Protects national wildlife	16 U.S.C. 668 50 CFR 27	Restricts activities within a National Wildlife Refuge.	Not an ARAR since site is not a wildlife refuge.
Wild and Scenic Rivers Act	Prohibits adverse effects on scenic rivers.	16 U.S.C. 1274 40 CFR 6:302	Prohibits adverse effects on scenic rivers.	Not an ARAR since site is not on a river.
Clean Water Act	Prohibits discharge of dredged or fill material into wetlands	33 U.S.C. 1251 Section 404, 40 CFR 230, 231	Prohibits discharge of dredged or fill material into wetlands without a permit. Preserves and enhances wetlands.	ARAR for remedial alternatives which involve disturbance to wetlands.
Endangered Species Act	Protects endangered species	16 U.S.C. 1531	Restricts activities where endangered species may be present.	ARAR if endangered species are observed at the site during ecological site assessments.
Policy Floodplains/Wetlands Assessment	Floodplain assessment	EPA 1985 Statement	Provides federal policy for the assessment of floodplains and wetlands	ARAR for remedial alternatives that affect wetlands and floodplains.
National Historic Preservation Act	Protects historic places	16 U.S.C. 470	Requires federal agencies to take into account the effect of any federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or is eligible for inclusion in the National Register of Historic Places.	Not and ARAR since there are no areas that are included or eligible for inclusion in the National Register of Historic Places.
Historic Sites, Buildings and Antiquities Act	Protects national landmarks	16 U.S.C. ss 461-457	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Not and ARAR since there are no areas that are included or eligible for inclusion in the National Register of Historic Places.
U.S. Army Corps of Engineers Nationwide Permit Program	Army Corp. of Engineers Permit Program	33 CFR 330	Prohibits activity that adversely affects a wetland if a practical alternative that has less effect is available.	ARAR for remedial alternatives which have the potential to affect wetlands.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
Rivers and Harbors Act of 1899	Army Corp. of Engineers Permit Program	33 CFR 320-330	Establishes a permit program for dams, dikes, dredging, and other construction in navigable waters of the U.S.	Not and ARAR since site is not located with area covered by regulation.
Executive Order Protecting Wetlands	Protection of Wetlands	Executive Order No. 11990	Requires Federal agencies to minimize the destruction, loss, or degradation of all wetlands affected by Federal activities.	ARAR for remedial alternatives which have the potential to affect wetlands.
Fish and Wildlife Coordination Act	Requires approval for modification of water body	16 U.S.C. 661 40 CFR 2 6:302(g)	Requires consultation with the U.S. Fish and Wildlife Services when a Federal department or agency proposes or authorizes any modification of any stream or other water body, and adequate provision for protection of fish and wildlife resources.	ARAR if action is covered by regulation.
National Ambient Air Quality Standards (NAAQS)	Air Quality Standards	40 CFR 50	Establishes non-attainment zones with respect to health-based criteria.	ARAR for remedial activities which emit restricted contaminants into the atmosphere.
Federal Endangered and Non-Game Species Act	Protection of threatened and endangered species	N.J.S.A. 23:2A-1	Standards for the protection of threatened and endangered species.	ARAR if any species exist at the site.
Flood Hazard Area Regulations	Protection of floodplains	N.J.A.C. 7:13	Protects floodplains through permitting requirements for construction and development activities	ARAR if remedial activities are located in or near a 100- or 500-year floodplain.
Flood Hazard Area Control Act	Delineates flood hazard areas	N.J.S.A. 58: 16A-50	Delineates flood hazard areas and regulates use.	ARAR if remedial activities are in or near a 100- or 500-year floodplain.
Wetland Act of 1970	Establishes wetland regulated activities	N.J.S.A. 13:9A-1 et.seq.	Establishes listing and permitting requirements for regulated activities	ARAR. Establishes listing and permitting requirements for regulated activities
Freshwater Wetlands Protection Act	Establishes freshwater wetlands regulated activities	N.J.S.A. 13:9B	Establishes listings and permitting requirements for regulated activities in state freshwater wetlands	Potential ARAR. Establishes listings and permitting requirements for regulated activities in state freshwater wetlands
Open Lands Management	Considers recreational projects during remediation	N.J.A.C. 7:2-12.1 et.seq.	Considers impact of remedial actions on recreational projects funded by Open Lands Management Grants.	Not an ARAR for remedial actions on recreational projects funded by Open Lands Management Grants.
Natural Areas System	Protects natural area sites	N.J.A.C. 7:2-11	Protects natural area sites listed under the Natural Areas Register.	Not an ARAR since site is not listed on the Natural Areas Register.
State Trails System	Protects state trails	N.J.S.A. 13:8-30 et. seq.	Requires that use of trail does not interfere with nature; maintains natural and scenic qualities.	Not an ARAR since site does not have trails.

Act/Authority	Criteria/Issues	Citation	Brief Description	Applicability
New Jersey Wild and Scenic Rivers System	Protects Scenic River systems	N.J.S.A. 13:8-45 et. seq.	Governs component river area, flood hazard area, or part of state park, wildlife refuge or similar area.	Not an ARAR since site is not component river area, flood hazard area, or part of state park, wildlife refuge or similar area.
New Jersey Threatened Plant Species	Lists threatened plant species.	New Jersey's Threatened Plan Species	Lists threatened plant species.	ARAR if remedial actions impact threatened plant species.
Endangered Plant/Animal Species Habitats	Lists threatened habitats where endangered species occur.	New Jersey's Endangered Species Act	Lists threatened habitats where endangered species occur.	ARAR if remedial actions impact endangered species.

5.0 Response Action Objectives (RAOs)

General RAOs are defined by the NCP and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (as amended by the Superfund Amendments and Reauthorization Act (SARA)) and apply to Superfund sites. CERCLA defines the statutory requirements for developing remedies.

Site-specific RAOs are established on the basis of the nature and extent of the contamination, the receptors that are currently and potentially threatened, and the potential for human and environmental exposure. Both the level of contamination and the potential exposure pathway are important considerations in developing RAOs at a site. For example, protection at a site can be achieved by both lowering the contaminant levels and by reducing the potential for exposure through a particular exposure route.

Preliminary remediation goals (PRGs) are site-specific, quantitative goals that define the extent of cleanup required to achieve the RAOs. The PRGs are developed during the FS, and are finalized in the ROD for the site.

This section presents the RAOs developed for the IRM for LNAPL at the Diamond Head site.

Specifically, for the LNAPL IRM at the Diamond Head site, the following three requirements in NJAC 7:26E-1.13(b)2(v) and NJAC 7:26E-6.1(d) were considered in developing the RAOs:

1. Removal or treatment of recoverable LNAPL where practicable
2. Containment of potentially mobile LNAPL where removal is not practicable
3. Treatment of residual LNAPL where practicable

Based on the results of the completed focused Phase 2 investigation, the LNAPL appears to be essentially immobile (self contained) under ambient conditions and poorly recoverable with any fluid recovery-based remediation system. For example, simplified recovery modeling of the LNAPL indicated that over a time period of 30 years, at most approximately 6 % of the LNAPL volume could be recovered.

Because the LNAPL is immobile and not practicably recoverable, the LNAPL can be considered residual and achieving the first two requirements above is not considered practicable. Therefore, the third requirement in NJAC 7:26E-1.13(b)2(v) and NJAC 7:26E-6.1(d) serves as the basis for establishing the RAO for this IRM:

- Treatment of residual LNAPL where practicable

This RAO is focused on reducing the LNAPL source mass to the maximum degree practicable and does not specifically address the co-located chemical contamination in the soils at the site. Some of this chemical contamination is likely associated with the LNAPL. Therefore, in reducing the mass of LNAPL, the IRM will also likely reduce some of the co-located chemical contamination and as a result, the unacceptable risks to potential human and ecological receptors associated with both the LNAPL and the co-located chemical contamination at the site.

The degree to which the reductions of both LNAPL and co-located chemical contamination occur during the IRM implementation is important. Treatability testing of technology(ies) selected for IRM implementation is recommended in order to evaluate ways to optimize the

effectiveness of the technology(ies). This could lead to achievement of future RAOs that will be established for the entire site and ultimately to overall cost savings at the site. While these reductions cannot be quantified at the time of preparation of this TM, the effectiveness of each retained technology is presented in terms of LNAPL source reduction and the technology's ability to reduce concentrations of other chemicals present at the site.

Following completion of the IRM, additional investigations are expected to be needed to determine the concentration and risk posed by remaining chemical contamination at the site. The overall site remedial action would then focus on addressing this residual chemical contamination. It is, therefore, important that the technology selected for LNAPL treatment does not interfere with future investigations or remedial actions that may be needed for the remaining chemical contamination at the site. This is also factored in to the assessment of technologies presented in this TM.

6.0 Preliminary Remedial Goals (PRGs)

Remediation goals are site-specific goals that define the extent of cleanup required to achieve the RAOs. To meet the RAO for LNAPL within the source area at the site, Preliminary Remedial Goals (PRGs) were developed to aid in defining the extent of contaminated media requiring remedial action. There are no numeric chemical specific ARARs for LNAPL. The ARARs are set based on what can be practically achieved by the remedial technologies given the LNAPL nature and extent and site characteristics which govern its setting. Therefore, the PRGs for the residual LNAPL are defined as follows:

- Reduce mass of residual LNAPL to the maximum degree practicable for the selected IRM

It should be noted that different technologies will leave varying amounts of LNAPL in the treated areas of the site; no technology identified and included in this TM (except for excavation and offsite disposal) is expected by itself to completely remove the LNAPL from the site. Therefore, the maximum practicable degree of LNAPL reduction will be empirically determined during the process of IRM implementation. This will be achieved by using an observational approach based on actual system operation and monitoring data to assess and predict the theoretical maximum amount of LNAPL that can be recovered and compare to actual recoveries. System operation will continue, with optimization and modifications made to maximize effectiveness, until a point of diminishing returns occurs where additional operation is not expected to appreciably improve site conditions. The remaining site conditions will then be made protective through implementation of the overall remedy for the site.

It also should be noted that following the implementation of this IRM, additional technologies may provide further removal of LNAPL mass at the site. For example, following the application of in Situ bioremediation, In Situ bio sparging may be used as a further polishing step. Because at this time, the degree of LNAPL mass removal that can be accomplished by a single technology cannot be predicted, this FFS is conducted for the development of a single IRM for the LNAPL treatment. Further treatment / polishing for the LNAPL, if desired following this IRM, can be achieved during the implementation of the overall remedy selected for the site.

7.0 Identification, Screening, and Evaluation of Remedial Technologies

7.1 General Response Actions (GRAs)

General response actions are actions that might be undertaken to satisfy the RAOs for a site. After the RAOs and PRGs were developed for the LNAPL IRM, general response actions consistent with these objectives were identified. General response actions were then further divided into a series of specific technologies and process options, which were then screened to assess their applicability and potential effectiveness for the LNAPL found at the site.

The GRAs for LNAPL are presented in Table 2 along with an overview of what the GRA would entail.

TABLE 2
General Response Actions for LNAPL
Diamond Head Oil Superfund Site, Kearny, New Jersey

General Response Action	Evaluation
No Action	Required by the National Contingency Plan for comparison to other actions.
Monitoring	Used in conjunction with other containment and treatment GRAs to monitor effectiveness.
Institutional Controls	Reduces the likelihood of exposure to the LNAPL (direct contact, ingestion, or inhalation).
Monitored Natural Attenuation	Reduces LNAPL mobility, toxicity, and volume through natural physical, chemical, and biological processes. The main processes include dissolution, biodegradation, and volatilization.
Containment	Minimizes exposure to LNAPL by confining and reducing its mobility.
In Situ Treatment	Reduces mobility, toxicity, and volume of LNAPL through in-place treatment using chemical, physical, or biological treatment processes.
Fluid Collection, Treatment, Discharge, and Disposal	Involves removal of LNAPL from the ground via fluid pumping. Therefore, collection reduces the volume of LNAPL. While under ambient conditions, the LNAPL is not mobile and may not be readily recoverable, some In Situ technologies may change the LNAPL characteristics so that it is more readily recoverable. If water is collected with the recovered LNAPL, it would need to be treated and the treated effluent may be discharged to surface water, groundwater, or a sewer system. The recovered LNAPL will need to be disposed of offsite.
Soil Excavation, Treatment, and Disposal	Reduces volume of LNAPL-contaminated media via excavation and treatment / or removal from the site. Some dewatering would likely be required during excavation and the water would need to be treated and disposed as discussed above for Fluid Collection. Treatment of the excavated material may be done onsite and the treated material used as backfill. Or the material may be transported for offsite disposal.

7.2 Screening and Evaluation Criteria for Selecting Remedial Technologies

The technology types and process options available for remediation of LNAPL were screened using a two-step process as described below.

First, screening of technology methods began with the development of an inventory of technology types and process options based on professional experience, published sources, computer databases, and other available documentation for the general response actions identified above. Each technology type and process option included is either a demonstrated, proven process or a potential process that has undergone laboratory trials or bench-scale testing. The technology types and process options were then screened based on technical implementability. The following factors were considered in this evaluation:

- State of technology development
- Site conditions
- LNAPL characteristics
- Nature and extent of LNAPL contamination
- Other factors that could affect the effectiveness of the technology

The technology types and process options that were retained after initial screening under each of the GRAs were then evaluated based on the criteria of implementability, effectiveness, and cost. These criteria are described below:

- **Implementability** — "Implementability" refers to the relative degree of difficulty anticipated in implementing a particular process option under regulatory, technical, and schedule constraints posed at the site. Implementability is evaluated in terms of both the technical and administrative feasibility of constructing, operating, and maintaining the technology. Technical feasibility refers to the ability to construct, reliably operate, and comply with regulatory requirements during implementation of an IRM. Technical feasibility also refers to the future operation, maintenance, and monitoring after the remedial action has been completed and the ability to implement the IRM consistent with proposed future land use standards. Administrative feasibility refers to the ability to obtain approvals and permits from regulatory agencies; the availability and capacity of treatment, storage, and disposal services; and the requirements for and availability of specialized equipment and technicians.

- **Effectiveness** — The effectiveness of a process option was evaluated based on the ability of the process option to meet the RAO under the conditions and limitations present at the site. The NCP defines effectiveness as the "degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risk, affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection." The key aspect considered in this FFS was the effectiveness of each technology in treating the residual LNAPL at the site. If considered to be effective for LNAPL, consideration was also given to the effectiveness of the technology in treating co-located chemical contamination.

- **Cost** — The primary purpose of the cost screening criterion is to allow for a comparison of rough costs associated with the technologies. The cost criterion addresses costs of construction and long-term costs to operate and maintain technologies that are part of an alternative. At this point, the cost criterion was qualitative and used for rough comparative purposes only; the costs of technologies were described comparatively as 'low', 'moderate' and 'high', with the 'high' qualifier indicating a high cost.

Site specific considerations supporting the technology ratings for implementability, effectiveness, and cost are described below.

Technologies which provided the following were given higher rating:

- Ability to treat residual LNAPL and chemical contaminants of potential concern (COPCs) identified during the Phase 1 RI conducted at the site (which may be within the LNAPL matrix or adsorbed onto the soil)
- Minimal impact to future remediation and site redevelopment activities
- Minimal environmental impact during remedy implementation (i.e., considering sustainability criteria such as green house gas emissions and non-renewable energy consumption)
- Potential to achieve significant residual LNAPL reduction in extremely heterogeneous lithologic setting

Technologies that were determined to potentially interfere with future remedial investigations or full-scale remedial measures for soil or groundwater were screened from further consideration. For instance, technologies such as In Situ solidification/stabilization with cement additive would potentially interfere with future investigations or remedial measures and were therefore screened from further consideration

7.3 Screening and Evaluation Results

Table 3 presents the technologies which were retained after initial screening and the results of their evaluation relative to the 3 criteria of implementability, effectiveness, and cost. In Table 3, the technologies that are not considered feasible after screening are shown in italicized text on the table. Technologies retained after screening are bolded. Screening comments are also provided for each technology. Based on the evaluation provided in Table 3, the following technologies were retained under each GRA for further consideration in assembling remedial alternatives:

- **No Action** – Retained to meet the requirements of the National Contingency Plan. No remedial technologies are implemented with this option.
- **Monitoring** – Retained to monitor the effectiveness of the chosen remedial action over the course of time. This may include monitoring of LNAPL and groundwater concentrations and water and LNAPL levels in wells over the course of IRM implementation.
- **Institutional Controls** - Institutional controls for soil consist of restricting access to contaminated soil through land use restrictions (such as deed notices under NJDEP requirements).
- **Containment** – Passive hydraulic controls including slurry or sheet pile wall were retained to provide a physical barrier to groundwater migration if excavation and dewatering are required.
- **In Situ Treatment** – The technologies retained for the In Situ treatment of LNAPL include the following:

  Mixing of soil in-place – This technology is retained to supplement other In Situ technologies that require the mixing in of treatment amendments.

  Enhanced Bioremediation – This technology involves degradation of contaminants through aerobic or anaerobic processes by stimulating biological growth through addition of an organic substrate and/or nutrients.

Biosparging – This technology involves biologic degradation of organics through stimulation of aerobic organisms by the addition of oxygen. It is typically conducted using low air flow rates so there is no need for vapor capture.

- **Fluid Collection, Treatment, Discharge (Treated Water), and Disposal (LNAPL)** – The technologies retained for the treatment of water from dewatering during excavation / construction activities include the following:

  Fluids Treatment – Treatment would be needed for any water extracted during dewatering. Treatment technologies for the extracted water would depend on the dissolved contamination in the water (LNAPL as well as chemical contaminants). Technologies that may be used include oil/water separation, air stripping, steam stripping, adsorption, and precipitation.

  Fluid Discharge – The treated groundwater may be discharged to surface water or Publicly Owned Treatment Work (POTW).

  Fluid Disposal – The recovered LNAPL would require transport and disposal at an offsite appropriately permitted facility.

- **Vapor Treatment** – Adsorption was retained as the technology to treat vapor emissions from treatment systems.

- **Soil Excavation, Treatment, and Disposal** – The technologies retained include the following:

  Excavation – This is the physical removal of LNAPL-contaminated soils to the target depth. This technology is generally considered to depths of less than approximately 20 feet, which is the general limitation of standard excavation equipment. Excavation of soils below the shallow water table would require dewatering, water treatment, disposal of the treated water, and disposal of the LNAPL recovered from the water.

  Treatment

  - *Ex Situ Stabilization* – This technology involves the addition of a solidification agent such as cement to prepare the material for transportation and to meet LDRs, if needed.
  - *Ex Situ Soil Washing* – Surfactants, co-solvents, and/or acidic/basic solutions are used to cleanse soil and desorb and dissolve contaminants including residual LNAPL and other COPCs. Soil is processed in an on-site slurry reactor and water treatment facility. Soil can then be replaced onsite for disposal after LDRs are met.

  Disposal – This technology involves the disposal of removed material at an offsite appropriately permitted landfill or backfilling onsite after treatment as well as disposal of the solutions from the soil washing.

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
No Action	No Further Action	None	No action.					Required by NCP for comparison with other alternatives; does not meet RAOs.
Monitoring	Monitoring	Measuring LNAPL thickness Groundwater sampling	Monitor the effectiveness of the chosen IRM over the course of time.	High	Low	Low	Low	Does not meet RAOs when implemented alone; is applicable and effective in conjunction with other technologies.
Institutional Controls	Institutional Controls	Land use restrictions	Restrict access to LNAPL-contaminated soils through local ordinances, building permits, restrictive covenants on property deeds (Deed Notice) and state registries of contaminated sites.	Moderate	Low	Low	Low	Does not meet RAOs when implemented alone; may be applicable in conjunction with other technologies.
	Groundwater Use Restrictions	*Access restrictions to groundwater and LNAPL*	*Establish a Classification Exception Area (CEA) for the area impacted by LNAPL, which will impose restrictions on groundwater use.*	*Moderate*	*Low*	*Low*	*Low to moderate*	*Since this is an IRM, the applicability of groundwater use restrictions would need to be determined as part of an overall remedy for the site. Therefore, not retained for further consideration.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
Monitored Natural Attenuation (MNA)	*Monitored Natural Attenuation*	*Monitored natural attenuation of groundwater*	*Use of naturally occurring physical, chemical and biological processes such as dissolution, biodegradation and volatilization to reduce LNAPL concentrations.*	*High*	*Low*	*Low*	*Moderate*	*Based on NJAC 7:26E-6.1(d), "...natural remediation of free and/or residual product will not be allowed." Technically infeasible for the LNAPL at the site as demonstrated by its continuing presence. Does not meet RAOs.*
Containment	**Passive Hydraulic Controls**	**Slurry or sheet-pile wall**	**Physical barrier to groundwater migration.**	**Moderate**	**Low**	**Low**	**Low to Moderate**	**Does not meet the RAO by itself. LNAPL is essentially immobile and therefore containment technologies would not provide added effectiveness. However, may need to be applied if excavation with dewatering is needed in order to control the flow of groundwater into the excavated area.**
	Vertical Subsurface Barriers	*Grout curtain*	*Create subsurface barrier to horizontal GW flow by grout injection.*	*Moderate*	*Low*	*Low*	*Moderate*	*Does not meet the RAO. LNAPL is essentially immobile and therefore containment technologies would not provide added effectiveness.*
	Surface Controls	*Grading*	*Reshape topography to control infiltration, runoff, and erosion.*	*High*	*Low*	*Low*	*Low*	*Does not meet the RAO. Not effective unless used in conjunction with other technologies.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Revegetation	*Add topsoil, seed and fertilize to establish vegetation (to control erosion and reduce infiltration).*	*High*	*Low*	*Low*	*Low*	*Does not meet the RAO. Not effective unless used in conjunction with other technologies.*
	Horizontal Subsurface Barriers	*Block displacement*	*Encapsulate block of soil with grout in conjunction with vertical barriers.*	*Moderate*	*Low*	*Low*	*Moderate to High*	*Does not meet the RAO. LNAPL is essentially immobile and therefore containment technologies would not provide added effectiveness.*
	Cover	*Soil*	*Place clay over contaminated soils.*	*High*	*Low*	*Low*	*Moderate*	*Does not meet the RAO. LNAPL is essentially immobile and significantly submerged below the water table and therefore containment technologies would not provide added effectiveness.*
		Multi-layer	*Cap includes a 2 foot thick clay layer and an impermeable geomembrane liner. In addition, a drainage layer and freeze-thaw protective layer are included in cap.*	*Moderate*	*Low*	*Low*	*High*	*Does not meet the RAO. LNAPL is essentially immobile and significantly submerged below the water table and therefore containment technologies would not provide added effectiveness.*
		Asphalt	*Place asphalt or concrete over contaminated soils.*	*Moderate*	*Low*	*Low*	*Moderate*	*Does not meet the RAO. LNAPL is essentially immobile and significantly submerged below the water table and therefore containment technologies would not provide added effectiveness.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
In Situ Treatment	Physical/ Chemical	*In Situ chemical oxidation (ISCO)*	*Degrade contaminants by chemical oxidation. Typical oxidants include ozone, hydrogen peroxide, permanganate, and persulfate.*	*Low, highly dependent on the quantity requiring oxidation*	*Moderate to high*	*Low*	*High*	*This technology would be difficult to implement and is expected to be cost-prohibitive. The quantity of reagent required to oxidize LNAPL in Situ would be difficult to inject and cost-prohibitive; multiple applications may be required. This technology is unproven for large LNAPL sites. It is therefore screened from further consideration.*
		Stabilization / Solidification	*Immobilize contaminants using solidification agents.*	*High*	*Moderate*	*Moderate*	*High*	*This technology may meet the RAO. This technology would be effective to treat some classes of chemical contaminants associated with the LNAPL - metals. However, application of this technology may prohibit access to the contaminated media for future remedial investigation/remedial actions because of the addition of stabilizing agents and is therefore screened from further consideration.*
		Shallow soil mixing	**Mixing of soil in-place using large augers to mix in treatment amendments and reduce LNAPL concentrations.**	**High**	**Low**	**Low**	**High**	**Feasible treatment delivery method for treatment technologies for residual LNAPL and other COPCs. Will not meet RAO by itself and therefore would be retained only to compliment other technologies.**

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Air sparging	*Inject air into groundwater to volatilize and enhance aerobic biodegradation of amenable contaminants. This is often combined with the use of SVE to capture the air.*	*Low to moderate*	*Low to moderate*	*Low*	*Moderate to high*	*This technology is not expected to meet the RAO. It is not expected to be effective for the significant quantities of highly LNAPL-saturated soil and it will be difficult to implement given the subsurface heterogeneity at the site. It is therefore screened from further consideration.*
		Soil vapor extraction (SVE)	*Extract vapor from the subsurface and remove contaminants via the vapor stream through desorption and volatilization mechanisms.*	*Low*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO and can not be implemented given the shallow depth to water and largely submerged LNAPL at this site. This technology is not expected to be effective for the significant quantities of highly LNAPL-saturated soil and it will be difficult to implement given the subsurface heterogeneity at the site. It is therefore screened from further consideration.*
		Washing / Flushing	*Wash or flush soil with water, surfactant, or co-solvent.*	*Moderate*	*Low*	*Moderate*	*High*	*This technology is not expected to meet the RAO as it will not be effective in highly heterogeneous settings with highly viscous LNAPL. This technology is not expected to significantly reduce the volume of LNAPL. It is therefore screened from further consideration.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Vitrification	*Melt/solidify soil matrix using electric currents.*	*Low*	*Moderate*	*High*	*High*	*This technology would meet the RAO, but would prevent access for future investigation/remediation efforts. There are limited commercial applications, and it is a very costly technology relative to other technologies. It is therefore screened from further consideration.*
		Pneumatic fracturing	*Fracturing of the consolidated formation to increase permeability and thus increasing effectiveness of In Situ treatment.*	*Low*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. IRM is focused on shallow LNAPL contamination and fracturing is not feasible at this shallow setting.*
	Biological	**Enhanced bioremediation**	**Degrade contaminants through aerobic or anaerobic processes by stimulating biological growth through addition of an organic substrate and/or nutrients.**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**This technology may meet the RAO. It can be applied via bio sparging (supplemented by the application of bacteria) or by combining bio sparging with the In Situ mixing of nutrients. Difficult to implement in highly heterogeneous setting and may require some removal of debris from the target area. As some classes of contaminants will not be addressed (e.g., metals, PCBs, pesticides), the technology will require revisiting areas after completion of the IRM to treat for these contaminants.**

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Phytoremediation	*Phytoremediation uses plants and microbes associated with the plant root system to stabilize, degrade, or extract contaminants from the soil and groundwater by either adsorption or absorption.*	*High*	*Low*	*Moderate*	*Low*	*This technology is not expected to meet the RAO. Not effective for LNAPL-saturated soil. It is therefore screened from further consideration.*
		Biosparging	**Biologically degrade organics through stimulation of aerobic organisms by the addition of oxygen. Typically conducted using low air flow rates so there is no need for vapor capture.**	**Moderate**	**Low to moderate**	**Moderate**	**Low to Moderate**	**This technology may meet the RAO but would require significant time. Difficult to implement in highly heterogeneous setting and may require some removal of debris from the target area. As some classes of contaminants will not be addressed (e.g., metals, PCBs, pesticides), the technology will require revisiting areas after completion of the IRM to treat for these contaminants.**
	Thermal	*Hot air or steam stripping*	*Inject hot air or steam/ to vaporize volatile and semi-volatile contaminants and recover the vapors.*	*Low, difficult to implement with shallow vadose zone*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology is difficult to implement; it would result in the production of steam and vapors that would be difficult to collect given the shallow depth to water. This technology is less implementable than other In Situ thermal technologies and is therefore screened from further consideration.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Conductive heating	*Application of conductive heat to the subsurface to increase soil temperature, decrease the viscosity of the LNAPL, and increase its mobility. Heat can be controlled to stay below temperatures that would create offgas.*	*Moderate*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology will slightly reduce the viscosity of the LNAPL but the degree of reduction expected would not increase its mobility and recoverability.*
		Electric resistance heating	*Application of an electrical current through the soil to increase soil temperature, decrease the viscosity of the LNAPL, and increase its mobility. Electrical current can be controlled to keep soil below temperatures that would create offgas.*	*Low to Moderate*	*Low*	*Low*	*High*	*This technology is not expected to meet the RAO. This technology will slightly reduce the viscosity of the LNAPL but the degree of reduction expected would not increase its mobility and recoverability.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Radio frequency heating	Use network of Radio Frequency Transmitters to heat soil; vaporize volatile and semi-volatile compounds, and collect them with a vapor extraction system.	Low	Low	Low	High	This technology is not expected to meet the RAO. This technology is expected to have limited effectiveness for residual LNAPL treatment. Difficult to implement due to the collection of vapors required and limited vadose zone available at the site. Other more implementable In Situ thermal options are available.
Fluid Collection, Treatment, Discharge, Disposal	Collection - LNAPL extraction	Recovery trench	Trenches within areas of mobile LNAPL are installed and backfilled with low-permeability material such as pea gravel. LNAPL preferentially flows into the low-permeability material and collects in sumps for extraction.	High	Low	Low	Moderate	This technology cannot be used to recover LNAPL because of its high viscosity and low mobility. This technology is not needed to support the retained In Situ or Ex Situ treatment technologies.
		Recovery wells	Large-diameter boreholes are installed with extraction wells and sumps. The boreholes are backfilled with low-permeability material.	High	Low	Low	Moderate	This technology cannot be used to recover LNAPL because of its high viscosity and low mobility. This technology is not needed to support the retained In Situ or Ex Situ treatment technologies.

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
	Collection - Multi Phase Extraction	*Multi phase extraction*	*Simultaneous extraction of LNAPL, groundwater, and soil gas*	*Moderate*	*Low*	*Low*	*Moderate to High*	*This technology would have to be implemented in areas with high LNAPL mobility, and therefore combined with other In Situ technologies. Would result in extraction of water and some vapor which would require treatment. Screened from further consideration due to immobile nature of LNAPL and availability of simpler collection technologies.*
Fluid Collection, Treatment, Discharge, Disposal	**Treatment - Physical-Chemical**	**Oil/water separation**	**Phase separation process to remove LNAPL from water stream**	**High**	**High**	**Low**	**Low**	**This technology can be used Ex Situ to separate LNAPL recovered from water from dewatering operations needed to support alternative implementation.**
		Air stripping	**Phase separation from dissolved-phase to vapor-phase by forced air**	**High**	**Low**	**Moderate**	**Low**	**This technology can be used Ex Situ to treat groundwater recovered during dewatering operations needed to support alternative implementation.**
		Steam stripping	**Phase separation by steam and forced air**	**High**	**High**	**Moderate**	**Moderate to high**	**This technology can be used Ex Situ to treat groundwater recovered during dewatering operations needed to support alternative implementation. While this technology can be applied, it is more difficult to implement and more costly than other available technologies. If physical-chemical treatment of water is required, a representative process option will be retained.**

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Adsorption	Contaminants are removed from the waster stream by adsorption with Granular Activated Carbon or other adsorptive media such as activated clay	High	Moderate	Moderate	Moderate	This technology can be used Ex Situ to treat groundwater recovered during dewatering operations needed to support alternative implementation.
		Precipitation	Chemical flocculants are added to precipitate metals from solution	Moderate	Low	Moderate	High	This technology can be used Ex Situ to treat groundwater recovered during dewatering operations needed to support alternative implementation.
		Advanced oxidation	*Chemical, photo, or other oxidation process whereby organic contaminants are converted to carbon dioxide and water*	*Low*	*High*	*Moderate*	*High*	This technology can be used Ex Situ to treat groundwater recovered during dewatering operations needed to support alternative implementation. *Typically more difficult to implement and more costly than other available technologies with similar effectiveness, therefore screened from further consideration.*
Fluid Collection, Treatment, Discharge, Disposal	Discharge	Groundwater discharged to: Surface water POTW	Includes various options for the discharge of treated groundwater.	Moderate	Low	Low	Low	Provides for the disposal of the treated groundwater recovered during dewatering operations in support of alternative implementation.

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
Fluid Collection, Treatment, Discharge, Disposal	Disposal	LNAPL disposal to: *Offsite Treatment* Storage and Disposal Facility (TSDF)	Disposal of extracted LNAPL at an offsite TSDF.	High	Low	Low	Low	Provides for the disposal of the LNAPL recovered from water from dewatering operations needed to support alternative implementation
Vapor Treatment, Discharge	Physical Treatment	Adsorption	Adsorption of contaminants in emissions from the treatment system	High	High	Moderate	Moderate	This technology is effective in removing VOCs from vapor emissions from other treatment technologies (such as air stripper off gas, thermal desorption off gas, etc.) where VOC concentrations are not highly concentrated.
		Catalytic oxidizer	Treatment of the contaminants in the emissions from the treatment system via catalytic oxidation	Moderate	High	Moderate	High	This technology can be used to treat high concentrations of VOCs in vapor. Requires supplemental fuel supply (either electric or natural gas) to heat air. Vapor emissions will likely not be high enough to warrant this technology, therefore, it is screened from further consideration.
	Discharge	Discharge to ambient air		Moderate	High	High	Low	Provides for the discharge of vapor to ambient air. Depending on ARARs, may need to be combined with vapor treatment technologies in order to meet discharge limits.

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
Excavation, Treatment, Disposal	Excavation of Soils	Backhoe / Excavation	Physically remove shallow soils.	Moderate	Moderate	High	High	This technology may support either removal the LNAPL-contaminated soil for Ex Situ treatment or offsite disposal or the construction of an In Situ treatment technology. The end result will depend on the type of treatment and disposal with which excavation is combined. Excavation is technically feasible to depths of about 20 feet. However, the shallow depth to water at this site would require construction dewatering during excavation, and this water would need to be treated and discharged. This technology may also treat or remove from the site other classes of chemical contaminants present in the soil.
Excavation, Treatment, Disposal	Treatment - Physical/ Chemical	Stabilization	Immobilize free product and contaminants through addition of stabilization agents to prepare material for transport and disposal.	Moderate	Moderate	Moderate	High	This technology would be effective to stabilize LNAPL Ex Situ and prepare the material for off site transport and disposal.

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Ex Situ soil washing	Surfactants, co-solvents, and/or acidic/basic solutions are used to cleanse soil and desorb and dissolve contaminants including residual LNAPL and other COPCs. Soil is processed in an on-site slurry reactor and water treatment facility. Soil can then be replaced onsite for disposal after LDRs are met.	Low	Moderate	High	High	This Ex Situ technology, combined with excavation, would meet the RAO and treat the LNAPL and associated classes of chemical contaminants to varying degree. This technology would be difficult to implement and require significant infrastructure for storage, application, and disposal or management of washing solutions.
	Treatment - Biological	*Ex Situ bioremediation*	*Enhance naturally occurring aerobic biological processes by homogenizing excavated soil, placing in an area, and adding oxygen or other substrates.*	*Low*	*Moderate*	*Moderate*	*Moderate*	*This Ex Situ technology would meet the RAO. However, given the volume of material requiring treatment, its implementation at this site would require significantly longer than its In Situ counterpart. It is therefore not retained for further consideration.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
	Treatment - Thermal	*Low-temperature thermal desorption*	*Processing soil through thermal treatment unit desorbs contaminants from soil and removes them in the off-gas, which also may require treatment.*	*Low*	*Low*	*Moderate*	*High*	*This technology is not expected to meet the RAO due to the nature of the LNAPL material*
		Onsite incineration	*Combust soils at high temperature.*	*Low*	*Moderate*	*Moderate*	*High*	*This technology would be moderately effective for Ex Situ treatment of LNAPL as well as most other classes of chemical contaminants present in the soil. However, it is significantly more costly that other ex-situ treatment methods, would require vapor treatment and permitting, and is therefore screened from further consideration.*
		Plasma	*Expose soils to super-heated plasma.*	*Low*	*High*	*High*	*High*	*Extensive treatability testing required; costs similar to incineration; unproven technology.*
		Infrared	*Decompose contaminants with infrared radiation.*	*Low, Unproven technology*	*Moderate to High*	*Moderate*	*High*	*Extensive treatability testing required; costs similar to incineration; unproven technology.*
		Wet air oxidation	*Use high temperature and pressure to thermally oxidize contaminants.*	*Low*	*Moderate to High*	*Moderate*	*High*	*Extensive treatability testing required; not cost competitive; unproven technology.*

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
		Offsite incineration	*Combust soils in offsite commercial incinerator.*	*High*	*Moderate to High*	*High*	*High*	*This technology may meet the RAO but would not be cost competitive.*
Excavation, Treatment, Disposal	*Disposal - Asphalt batching*	*Offsite asphalt plant*	*Incorporation of recovered LNAPL into asphalt material for reuse in paving applications.*	*High.*	*Moderate*	*Moderate*	*Low*	*Exposures to waste re-used from a Superfund site would be a concern. The physical and chemical characteristics of the recovered LNAPL may not be appropriate for asphalt batching and the quantity is not expected to be significant as LNAPL will be recovered only from water from the dewatering operations.*
	Disposal - Offsite	**RCRA Subtitle C or Subtitle D landfill**	**Remove excavated material from site for disposal in RCRA Subtitle C or D permitted TSDF.**	**Low**	**High**	**High**	**High**	**This technology will meet the RAO to remove the excavated material from the site through offsite disposal. Soils are likely below any hazardous waste characterization limits and can be disposed in a Subtitle D Landfill. However soils will be tested and any soils failing TCLP limits will require disposal in Subtitle C landfill.**

TABLE 3

TECHNOLOGY/PROCESS OPTION SCREENING AND EVALUATION

DIAMOND HEAD OIL SUPERFUND SITE, KEARNY, NEW JERSEY

General Response Action	Remedial Technologies	Process Options	Description	Technical Implementability	Effectiveness		Capital and O&M Cost	Screening Comments
					Residual LNAPL	COPCs in Subsurface Soil (A) OR Other Treated Media (B)		
	Disposal - Onsite	**Onsite placement of treated soil**	**Place material onsite after treatment.**	**High**	**High**	**High**	**Low**	**This technology is retained because, combined with excavation and treatment, it may meet the RAO to treat residual LNAPL. Soils can be treated and placed onsite. Classes of contaminants that were not addressed through the treatment will require revisiting areas for subsequent treatment. The contaminants that will require addressing will depend on the preceding treatment method.**

Note: Remedial technologies are screened for Implementability, Effectiveness, and Cost based on criteria rankings of "Low", "Moderate", and "High". Effectiveness is assessed relative to the effectiveness to meet the RAO for this LNAPL IRM. A high assessment for costs means that the cost of this technology / process options is high compared to others considered.
Remedial technologies in *blue italics* have been screened from further consideration because they prohibit access to contaminated media for future remedial investigation/remedial actions.
Remedial technologies in *red italics* have been screened from further consideration based on the screening criteria and whether the technology would meet the RAOs.
Remedial technologies in bold have been retained for inclusion in remedial alternatives.
SVE – soil vapor extraction
ISCO – in-situ chemical oxidation
IRM – Interim Remedial Measure
LNAPL – light non-aqueous phase liquid
NA – not applicable
A – Other COPCs in subsurface soil are listed in Table 4. B- Examples of other media to be treated are groundwater and air emissions from considered systems.

As previously noted, in addition to being applicable to the LNAPL, the treatment technologies identified above are expected to have varying degrees of effectiveness in reducing COPCs in soils. These reductions are mainly expected to occur as a result of a reduction in the mass of LNAPL following the application of the IRM technology. Some technologies may have additional effectiveness on treating chemical contamination adsorbed to the soil matrix. Table 4 shows the general applicability of the retained treatment technologies for LNAPL to the COPCs identified for soils during the Phase 1 RI.

TABLE 4
Applicability of Treatment Technologies for LNAPL to Site COPCs
Diamond Head Oil Superfund Site, Kearny, New Jersey

			Potential Applicability to COPCs (1):				
General response action	**Remedial technologies**	**Process option**	**VOCs**	**SVOCs**	**Pesticides**	**PCBs**	**Metals**
In Situ	Bioremediation	Aerobic bioremediation	Yes	Yes	Limited	Limited	No
		Anaerobic bioremediation	Yes	Yes	Limited	Limited	No
Excavate, treat, dispose	Excavate, treat, dispose (onsite or offsite)	Stabilization	Limited	Limited	Limited	Limited	Yes
		Soil washing	Yes	Yes	Yes	Yes	Yes
(1) Specific contaminants of potential concern (COPCs) identified during the Phase 1 RI conducted at the site as exceeding NJ soil standards are listed under each class. There are no soil standards for individual arochlors. Total PCB concentrations measured in soils during the Phase 1 RI exceeded the NJ standard for total PCBs but the individual arochlor concentrations were below this standard.			benzene, PCE, TCE, xylenes	PAHs, PCP	Aldrin, Dieldrin	Total PCB concentrations (1)	Sb, AS, Ba, Be, Cd, Cu, Pb, Hg, Ni, Th, Va, Zn

Following the qualitative screening, the remedial technology types and process options identified above as potentially viable for remediating the LNAPL at the site were carried forward for incorporation into remedial alternatives.

8.0 Conclusions

A preliminary screening and evaluation of remedial technologies was performed to identify those technologies, which based on qualitative assessment of implementability, effectiveness, and cost, should be considered further and included in remedial alternatives for the IRM to address the mass of LNAPL at the site. These technologies are expected to have varying degrees of effectiveness on the chemical contaminants found in the soils. As part of the remedial design, pilot testing is recommended to both assess the effectiveness as well as optimize the performance of the selected technologies in reducing both LNAPL and chemical contamination at the site.

9.0 References

CH2M HILL. Final Phase 1 Remedial Investigation Technical Memorandum, Diamond Head Oil Superfund Site, Kearny, New Jersey. February, 2005.